

Application No.: 09/471,173

R E M A R K S

No new matter is believed to be added to the application by this Amendment.

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Status of the Claims

Claims 2 and 13-23 are pending in the application. Claims 13-23 are newly presented for the Examiner's consideration. Support for the amendments to claim 2 can be found in Figure 2 and at page 13 of the specification. Support for newly added claim 13 can be found in Figure 3 and at page 14 of the specification. Support for newly added claim 14 can be found in Figures 3 and 4, and at page 18 of the specification. Support for newly added claims 15-17 can be found at page 5 of the specification. Support for newly added claims 18-20 can be found at page 7 of the specification. Support for newly added claims 21-23 can be found at page 15 of the specification.

Rejection Under 35 U.S.C. § 103(a) Over Mitani '463 in view of Gilmer '172 (Paragraphs 2-7 of the Office Action)

Claims 2 and 4-6 are rejected under 35 U.S.C. § 103(a) as being obvious over Mitani '463 (USP 6,191,463) in view of Gilmer '172 (USP 5,821,172). Applicants traverse this rejection and respectfully request reconsideration and withdrawal thereof.

The Present Invention and Its Advantages

The present invention pertains to a gate insulator interpositioned between a semiconductor substrate and the gate electrode. The gate insulator is a silicon dioxide material containing both nitrogen and halogen, e.g., fluorine, atoms. The nitrogen atom concentration in the gate insulator is more than $1 \times 10^{20} \text{ cm}^{-3}$. The insulator gate transistor of the invention can have a floating gate electrode and control gate electrode provided on the floating gate electrode with the interlayer insulator interposed between them.

The interdependence of nitrogen concentration, fluorine concentration and maximum transconductance is shown in Figure 3. The claimed transistor has an advantage in that the maximum transconductance hardly deteriorates. See page 14 of the specification.

In the invention, the gate insulator can have a thickness of 0.5-5 nm. This thickness range of the gate insulator allows stable film formation while modulating boron diffusion. See page 7 of the specification. The advantages of the invention pertaining to gate insulator thickness, nitrogen atom concentration of $1 \times 10^{20} \text{ cm}^{-3}$ or more and the relationship between stable film formation and boron penetration is further discussed at pages 13 and 16 of the specification.

Distinctions of the Present Invention Over Mitani '463 and Gilmer '172

Mitani '463 pertains to an apparatus and method of improving an insulating film on a semiconductor device. Mitani '463 discloses "A semiconductor device includes a semiconductor substrate, a first insulating film formed on the semiconductor substrate, and an electrode formed on the first insulating film. The first insulating film contains a halogen element and a combination of silicon and nitrogen or a combination of silicon, oxygen, and nitrogen." See abstract of Mitani '463.

Mitani '463 fails to disclose an oxygen atom concentration of more than $1 \times 10^{20} \text{ cm}^{-3}$. The Examiner acknowledges this failure of Mitani '463 at page 3 of the Office Action.

Gilmer '172 pertains to oxynitride dielectrics. Gilmer '172 at column 2, lines 15-18 discusses that incorporating nitrogen into the gate dielectric significantly reduces penetration of boron from the conductive gate into the transistor channel. Gilmer '172 at column 3, lines 34-35 states "The peak concentration of the nitrogen distribution is in the range of approximately 10^{17} to $10^{20} \text{ atoms/cm}^2$." This teaching, compared to the "more than $1 \times 10^{20} \text{ cm}^{-3}$ " set forth in instantly amended claim 2 of the present invention, demonstrates that Gilmer '172 teaches away from the present invention.

In the Office Action, the Examiner further asserts that it would be obvious to combine the nitrogen teachings of Gilmer '172' with the semiconductor device of Mitani '463 to produce an embodiment of the present invention. However, the semiconductor device of Mitani '463 is a capacitor (see claim 3 of Mitani '463) while the semiconductor device of Gilmer '172 is a transistor. As a result, the Examiner has failed to provide sufficient motivation to combine the references, and the *prima facie* case of obviousness has not been made for at least this reason alone.

Yet further, at page 3 of the Office Action, the Examiner asserts that no criticality has been shown regarding the thickness of the insulation layer. However, the specification clearly sets forth the criticality of the nitrogen concentration, insulation layer thickness and the resulting film formation and resistance to boron penetration at pages 7, 13 and 16. As a result, criticality of the parameters of the claimed invention are clear.

Therefore, a person having ordinary skill in the art would not be motivated to use any of the teachings of Mitani '463 in combination with Gilmer '172 to produce an embodiment of the present invention, and the *prima facie* case of obviousness has not been made. As a result, this rejection is overcome and withdrawal thereof is proper.



Rejection Under 35 U.S.C. § 103(a) Over Mitani '463 in view of De La Moneda '587 (Paragraph 8 of the Office Action)

Claim 3 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitani '463 in view of De La Moneda '587 (USP 4,016,587). Applicants traverse this rejection and respectfully request reconsideration and withdrawal thereof.

Claim 3 has been canceled by this Amendment. Accordingly, this rejection is rendered moot.

Conclusion

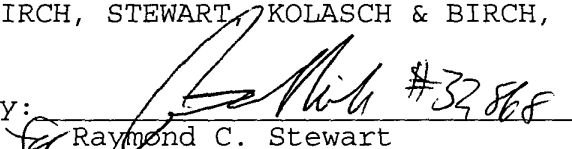
If the Examiner has any questions concerning this application, he is requested to contact Robert E. Goozner, Reg. No. 42,593, at (703) 205-8000 in the Washington, D.C. area.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

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Attachment: Version to Show Changes Made